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EFFECT OF FERTILIZER PLACEMENT AND SOIL WATER ON EMERGENCE OF YELLOW MUSTARD

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Introduction

Traditional crop production systems in the Pacific Northwest (PNW) Columbia Plateau are wheat/fallow rotations. These systems continue to degrade the natural resource base through soil erosion and loss of soil organic carbon (Rasmussen and Parton 1994). Elimination of the fallow season by annual cropping would reduce erosion and loss of soil organic carbon through oxidation. Planting broadleaf crops such as canola (*Brassica napus* L.*)* or yellow mustard (*Sinapis alba* L.) in rotation with wheat are potentially viable annual cropping systems for the PNW. Yellow mustard and canola seeds are very small round seeds that measure less than 1/16 inch in diameter. Because of their small size these seeds require shallow planting (Brandt 1992) and young seedlings are prone to water stress during germination and emergence. In the Columbia Plateau, this is a particular problem since prolonged periods of dry weather in the spring frequently occur (Rasmussen et al. 1998).

Fertilizer requirements for optimum yield of mustard and canola are similar to that of winter wheat (Wysocki et al. 1992). In the Columbia Plateau, typical recommendations are approximately 80 lb of N, 15 lb of P, and 10 lb of S for 2,000 lb/acre of grain produced by the crop. Placing fertilizer with or in close proximity to the seeds may create additional stress to the seedlings during germination and emergence.

To better understand these phenomena, a laboratory experiment was conducted to determine the effect of fertilizer placement, fertilizer amount, and soil water content on emergence of yellow mustard.

Materials and Methods

A laboratory experiment consisting of three replications of a combination of eight fertilizer and three soil water content treatments was conducted in a Walla Walla silt loam soil (Table 1). These water contents represented 1/4, 1/2, and 1 bar soil water tension, or 18.6, 16.6 and 14.8 percent gravimetric soil water content, respectively. The experiment consisted of planting AC Pennant mustard seeds in Walla Walla silt loam soil in 4- x 4- x 4-in pots, placing the pots in a growth chamber, and counting the number of seedlings that emerged each day after planting for 17 days.

In treatments 1 through 4, starter fertilizer (N- P_2O_5-K_2O = 16-20-0) at 0, 25, 50, and 100 lb/acre was placed with the seeds, respectively. For treatments 5 and 6, starter fertilizer (N- P_2O_5-K_2O = 16-20-0) at 50 lb/acre was placed 1 in below and 1 in to the side, and 2 in below and 2 in to the side of the seeds, respectively. A combination of the starter fertilizer at 50 lb/acre and urea (N- P_2O_5-K_2O = 46-0-0) at 172 lb/acre were placed 1 in below and 1 in to the side, and 2 in below and 2 in to the side of the seeds for treatments 7 and 8, respectively. The combination of three soil water contents,

Table 1. Fertilizer rates and placement location for mustard emergence experiment.

Treatment	Fertilizer amount		Fertilizer placement
	Starter (16-20-0)	Urea (46-0-0)	
	--------- lb/acre ---------		
1	0	0	None applied
2	25	0	With the seed
3	50	0	With the seed
4	100	0	With the seed
5	50	0	1 in by 1 in[1]
6	50	0	2 in by 2 in[2]
7	50	172	1 in by 1 in
8	50	172	2 in by 2 in

[1]1 in by 1 in indicates fertilizer was placed 1 in below and 1 in to the side of the seeds.
[2]2 in by 2 in indicates fertilizer was placed 2 in below and 2 in to the side of the seeds.

eight fertilizer rate and placement treatments, and three replications made a total of 72 experimental units.

Ten seeds of the mustard variety AC Pennant were planted 1/2 in deep in each pot. The amount of fertilizer placed in each pot represented 12-in row spacing in the field. To ensure soil aggregate size uniformity, soil was rolled and sifted through a 0.08-in (2-mm) sieve. Soil water content was adjusted by adding the appropriate amount of water to obtain 18.6, 16.6, and 14.8 percent gravimetric soil water contents. Seeds and fertilizer were potted using the following procedure: soil was compacted in the pots to a bulk density of 1.94 slugs/ft^3 (1g/cm^3) to the depth where fertilizer was to be located. Fertilizer was placed, and additional soil was added if needed and compacted. Then seeds were placed and 1/2 inch of soil compacted over the seeds. Pots were covered with Parafilm®[†] to prevent water loss through evaporation and placed in a growth chamber at 50^o F. When seedlings began to emerge, the Parafilm® was removed, the pots loosely covered with plastic wrap and a humidifier placed in the growth chamber to control evaporation loss from the pots. Emergence observations were made and recorded daily from day 1 through 10, and day 13 through 17 after planting.

Results and Discussion

The results of the study are summarized in Tables 2 and 3 with statistical differences between treatments indicated for each observation day. Table 2 shows that the percentage of plants emerged increased significantly until day 13 after planting. After day 13, the percentage of plants that emerged increased by less than 7 percent. Placing starter fertilizer (N-P_2O_5-K_2O = 16-20-0) with the seeds delayed and reduced emergence significantly (Fig. 1). Final emergence in the pots with 25, 50, and were 42, 93, and 98 percent lower than the 100 lb/acre of starter placed with the seeds final emergence in the pots that had no starter.

[†] Mention of trade name, proprietary product, or specific equipment does not constitute guarantee or endorsement by the USDA-ARS or Oregon State University, and does not imply the approval of the named product to the exclusion of other products that may be suitable.

The first seedlings emerged 7 days after planting. Fifteen of the 72 pots held emerged mustard plants on this day. By the end of the incubation period (17 days after planting), all of the treatments that had plant emergence on day 7 had reached 90 percent emergence or greater (with the exception of one treatment that only reached 80 percent), suggesting that earlier emergence is an indicator of a preferable seedbed condition.

Compared to treatments where starter fertilizer was placed with the seeds, placing starter fertilizer away from the seeds significantly improved emergence. Although the final (17 days after planting) percentage of plants emerged was not significantly different between treatments with no starter fertilizer and starter placed 1 in below and 1 in to the side of the seeds (Table 2), there was a significant delay in plant emergence (Fig. 2). When the starter was placed 2 ins below and 2 in to the side of the seeds, emergence rates and amounts were as fast and as high as the no starter treatment.

For two of the treatments, the full complement of fertilizer (50 lb/acre of 16-20-0 and 172 lb/acre of 46-0-0) was placed to the side and below the seeds. A slight delay in emergence occurred for fertilizer placed near the seeds (either 1 x 1 or 2 x 2 in) compared to no fertilizer placed at planting (Fig. 3) but the differences were not statistically significant (Table 2). Starter fertilizer (50 lb/acre of 16-20-0) placed 1 in to the side and 1 in below the seeds (treatment 5) created a reduced emergence compared to the full complement of fertilizer at the same placement (treatment 7) during initial emergence (Table 2). This difference was not statistically significant after day 7. It is not understood why this difference occurred.

The effect of soil water content on yellow mustard emergence can be seen in Figure 4. Results plotted in Figure 4 represent averages of all fertilizer treatments for each soil water content. The drier soil conditions at 14.8 and 16.6 percent delayed early emergence. Seven and 8 days after planting there were significantly more plants emerged in soil with 18.6 percent soil water content compared to soil with 14.8 and 16.6 percent (Table 3).

Although starter fertilizer placed with yellow mustard seeds at planting reduced and delayed emergence compared to banding fertilizer to the side and below the seeds, the effect of fertilizer placement on plant growth and yield needs to be determined before recommendations can be made concerning fertilizer placement and yellow mustard production.

Summary

Fertilizer placed with yellow mustard seed at rates as low as 25 lb/acre of 16-20-0 at planting delayed and reduced plant emergence in both moist soil (18.6 percent) and soil with marginal water content (14.8 percent) silt loam soil. Placing fertilizer 2 in to the side and 2 in below the seed reduced this stress condition during the seedling establishment period. These tests evaluated the effect of fertilizer placement and amount on plant emergence in a controlled environment. Additional field research is underway to determine fertilizer placement and amount on plant emergence, growth and yield.

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References

Brandt, S.A. 1992. Depths, rates and dates of seeding and yield of yellow mustard (*Sinapis alba* L.) in west-central Saskatchewan. Canadian Journal of Plant Science 72:351-359.

Rasmussen, P.E., and W.J. Parton. 1994. Long-term effects of residue management in wheat/fallow. I. Inputs, yield and soil organic matter. Soil Science Society of America Journal 58:523-530.

Rasmussen, P.E., W.A. Payne, and R.H. Goller. 1998. Thirty-year rainfall trends, implications for crop yield in the Columbia Plateau. Pages 35-40. *In* J.D. Williams (editor), 1998 Columbia Basin Agricultural Research Annual Report. Special Report No. 989, Agricultural Experiment Station, Oregon State University and USDA-Agricultural Research Service, Pendleton, OR.

Wysocki, D., S. Ott, M. Stoltz, and T. Chastain. 1992. Variety and planting date effects on dryland canola. Pages 32-37. *In* T. Chastain (editor), 1992 Columbia Basin Agricultural Research Annual Report. Special Report No. 894, Agricultural Experiment Station, Oregon State University and USDA-Agricultural Research Service, Pendleton, OR.

Table 2. Effect of fertilizer placement, amount and type on emergence of yellow mustard.

Treatment	Location	Fertilizer Amount	Type	Day after planting 7	8	9	10	13	14	15	16	17
		lb/acre		---------- percentage of seeds that produced plants ----------								
1		none	16-20-0	10abc1	49ab	84a	93a	94a	96a	96a	96a	96a
2	With Seed	25	16-20-0	0c	1c	7c	24c	49c	51c	53c	54c	56b
3	With Seed	50	16-20-0	0c	0c	1c	2d	4d	4d	6d	7d	7c
4	With Seed	100	16-20-0	0c	0c	0c	0d	2d	2d	2d	2d	2c
5	1 x 12	50	16-20-0	2c	34b	67b	78b	84b	87b	87b	88b	89a
6	2 x 2 3	50	16-20-0	16a	54a	78ab	91a	93ab	97a	97a	97a	97a
7	1 x 1	50 + 172	16-20-0 + Urea	12ab	48ab	73ab	84ab	90ab	90ab	90ab	90ab	90a
8	2 x 2	50 + 172	16-20-0 + Urea	7abc	43ab	76ab	88ab	91ab	93ab	94ab	96ab	96a

1 Means in the same column with the same letter are not significantly different as determined by the LSD test (P ∝ 0.05).
2 1 x 1 indicates fertilizer was placed one inch below and one inch to the side of the seeds.
3 2 x 2 indicates fertilizer was placed two inches below and two inches to the side of the seeds.

Table 3. Effect of soil water content on emergence of yellow mustard plants emerged in a Walla Walla silt loam soil.

Soil Water Content	Days after planting 7	8	9	10	13	14	15	16	17
percent		-------- percentage of seeds that produced plants --------							
14.8		22b	47a	57a	64a	66a	67a	68a	68a
16.6	2b	23b	45a	57a	63a	65a	65a	66a	66a
18.6	14a	42a	52a	59a	64a	64a	65a	65a	65a

1Means in the same column with the same letter are not significantly different as determined by the LSD test (P ∝ 0.05).

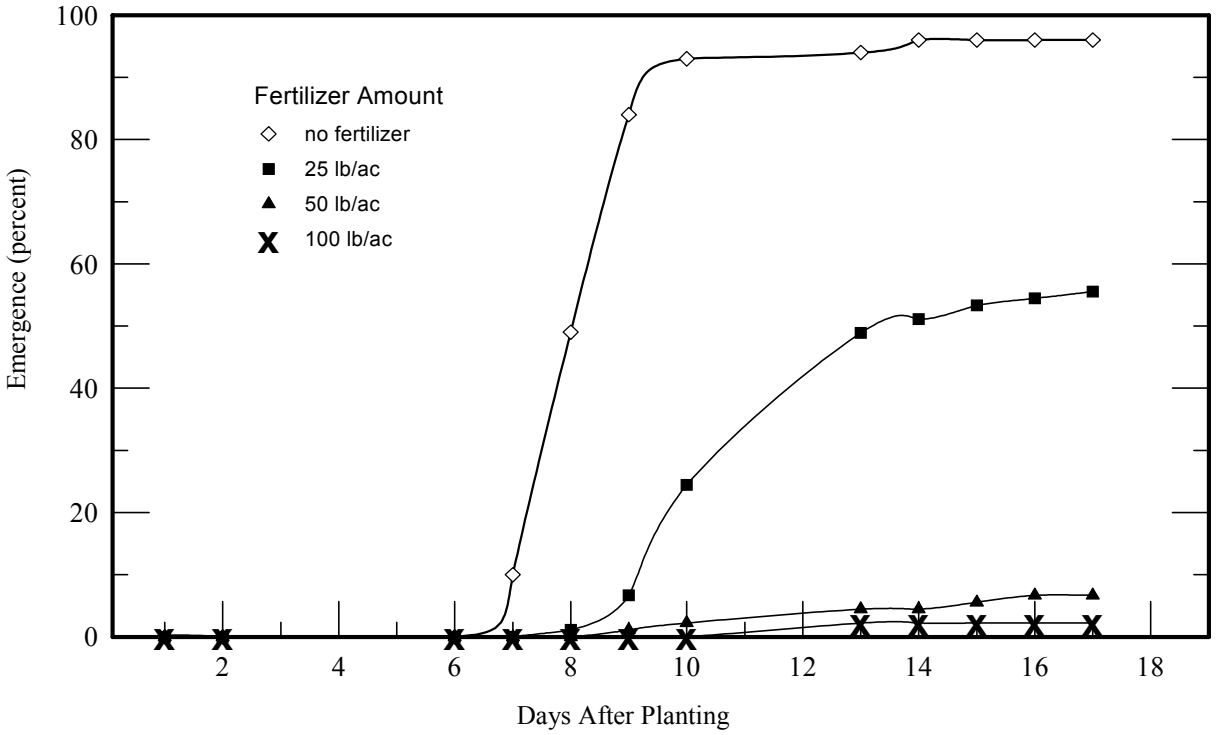

Figure 1. Effect of amount of starter fertilizer (N-P_2O_5-K_2O = 16-20-0) placed with the seed on emergence.

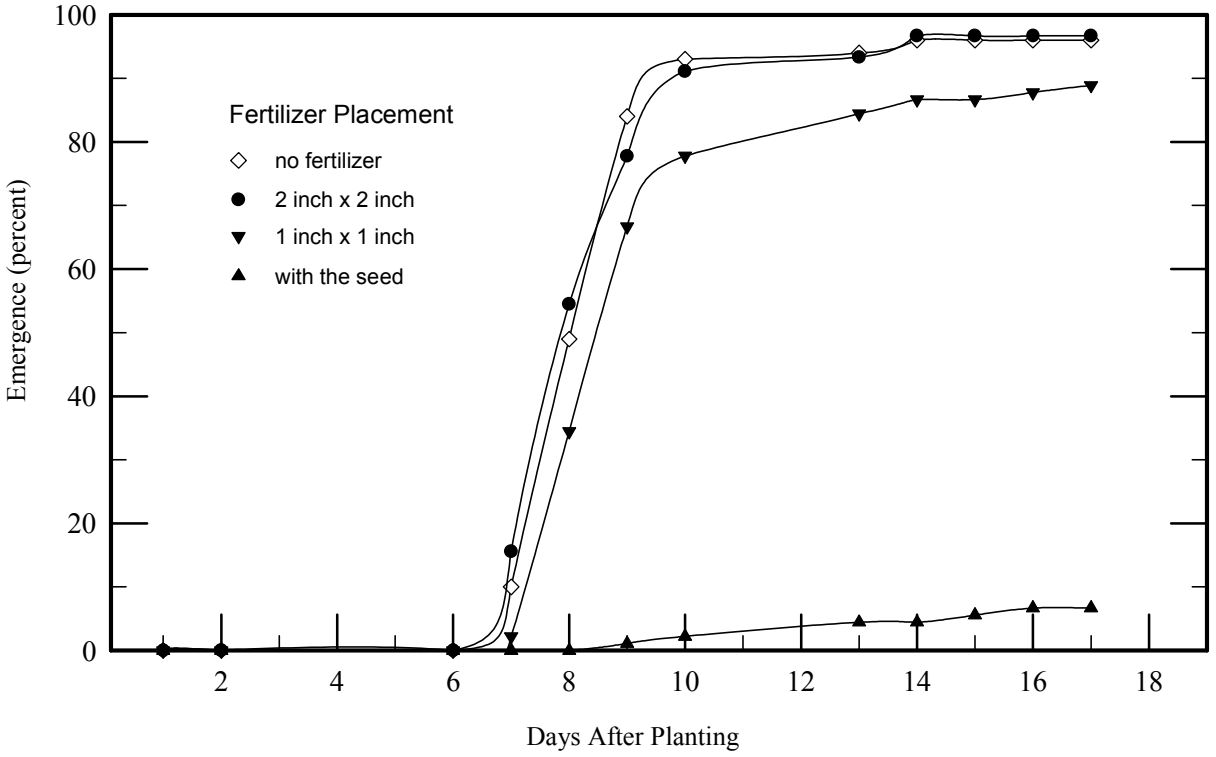

Figure 2. Effect of placement of starter fertilizer (N-P_2O_5-K_2O = 16-20-0) at 50 lb/acre on mustard emergence.

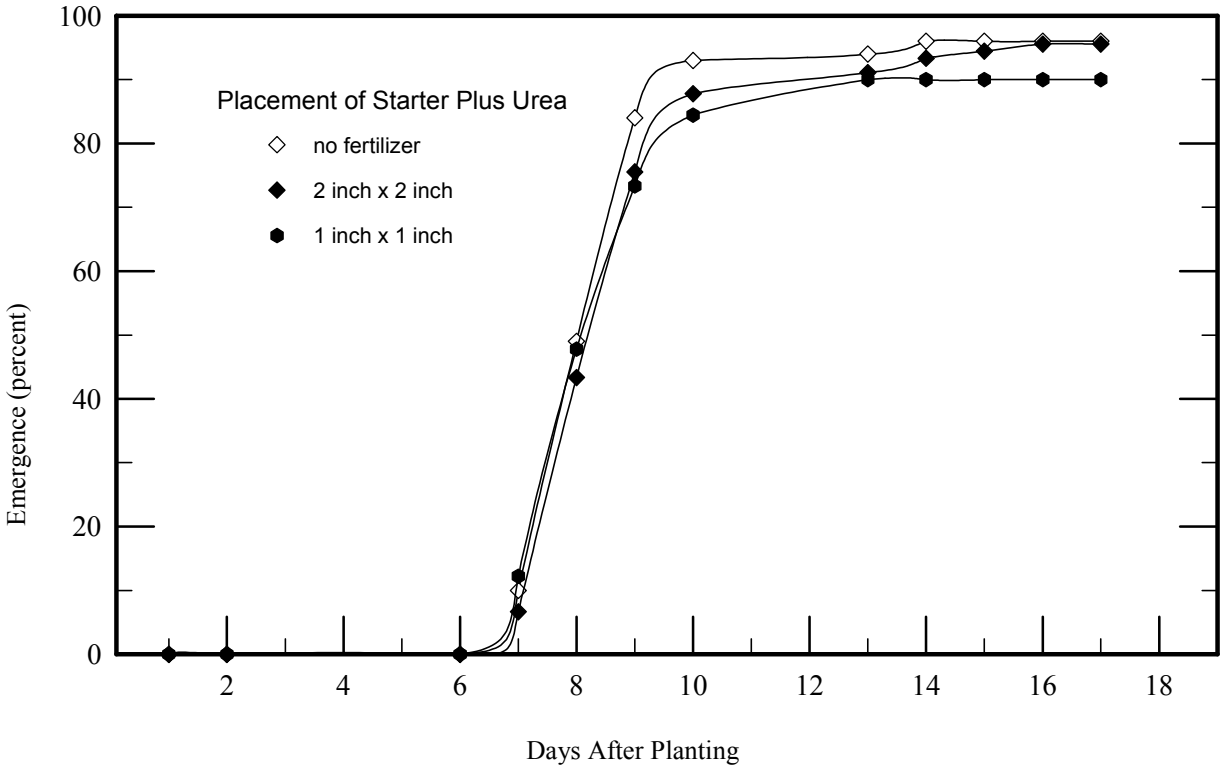

Figure 3. Effect of placement of starter ($N\text{-}P_2O_5\text{-}K_2O$ = 16-20-0) at 50 lb/acre plus urea fertilizer ($N\text{-}P_2O_5\text{-}K_2O$ = 46-0-0) at 172 lb/acre on mustard emergence.

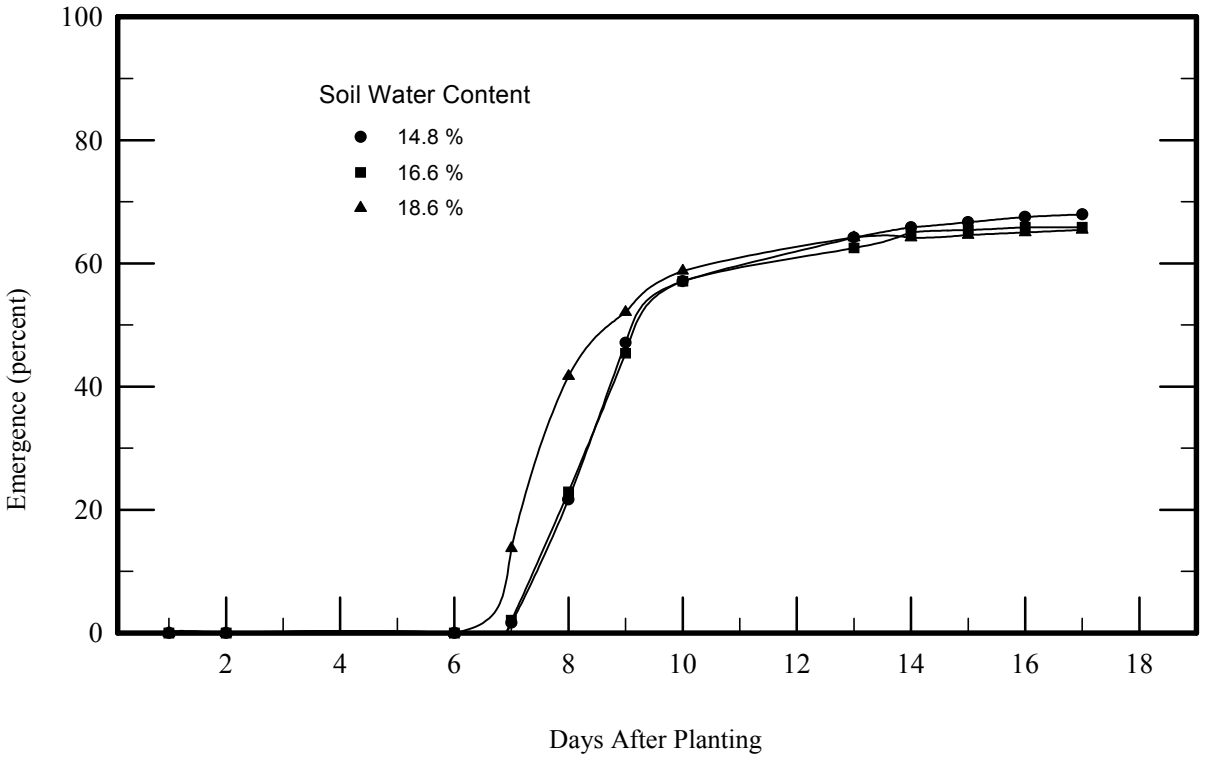

Figure 4. Mean effect of soil water content on mustard emergence for all fertilizer treatments.